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YELLOWFIN TUNA SPAWNING IN THE CENTRAL EQUATORIAL PACIFIC

BY HEENY S. H. YUEN AND FRED C. JUNE

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ABSTRACT

Material for this report was furnished by 740 laboratory determinations, supplemented by field determinations, of the stage of maturity of ovaries of yellowfin tuna (*Neothunnus macropterus*) caught in the central equatorial Pacific. The usual length at sexual maturity of yellowfin in this area was found to be about 120 cm., although yellowfin as small as 70 cm. may be mature. Spawning was found to occur throughout the area surveyed (approximately 10° N. to 8° S. latitude, 120° W. to 180° longitude). Other studies have indicated that this area is but part of a band of yellowfin spawning grounds which covers the entire equatorial Pacific.

In this investigation, residual eggs in various stages of resorption were examined and described. Of 25 ovaries examined, 22 were found to be infested with unidentified nematodes ranging from 0.5 to 4 cm. in length. The number of worms in an ovary was usually less than five, and the infestation did not appear serious enough to affect the function of the ovary.

CONTENTS

YELLOWFIN TUNA SPAWNING IN THE CENTRAL EQUATORIAL PACIFIC

By HEENY S. H. YUEN and FRED C. JUNE, *Fishery Research Biologists*

Because of the need for more knowledge about the spawning habits of the yellowfin tuna, *Neothunnus macropterus* (Temminck and Schlegel), a study was initiated as part of the tuna-research program of the Fish and Wildlife Service's Pacific Oceanic Fishery Investigations (POFI). Previous studies have been made of the reproduction of this species in various parts of the Pacific—by Schaefer and Marr (1948) and by Mead (1951) in Central American waters, by Bini (1952) off Chile and Peru, by June (1953) in Hawaiian waters, by Marr (1948) in the Marshall Islands, by Shimada (1951) near Kapingamarangi Island (1° N., 155° E.), and by Wade (1950 and 1951) in the Philippine Islands. This report is based on data from the central equatorial Pacific.

In this study we have investigated the time and place of spawning and the size of the fish at sexual maturity. Stages in the resorption of ripe eggs that were not spawned are incidentally described. The appearance of nematodes in the ovaries is noted, and its effect on egg production is discussed.

The research staff and vessel personnel assisted in the collection of ovaries and field data; Richard Shomura helped process the ovaries; Wilvan Van Campen translated the Japanese data; and Tamotsu Nakata prepared the illustrations.

SOURCES OF DATA

Ovaries collected on POFI exploratory-fishing trips from February 1950 to June 1954 provided most of the material for this study. The area of collection extended from 8° S. to 10° N. latitude and from 120° W. to 180° longitude.

The ovaries, preserved in 10-percent formalin, were brought back to the laboratory for examination. A record was kept of the date and the place of capture and the fork length of each fish. At the laboratory, the eggs were classified according to physical characteristics, as immature, intermediate, maturing, or ripe, as defined by June (1953). The "spawned out" category was omitted because of the difficulty in defining this class, but since only a fraction of the total number of eggs is emitted during spawning the remaining eggs permitted fish that had recently spawned to be classified into one of the four categories.

The principal features of the four categories are as follows:

Immature.—The eggs are translucent and range from 0.01 to 0.18 mm. in diameter.

Intermediate.—The largest eggs are semiopaque owing to the deposition of yolk granules; the diameters range from 0.18 to 0.40 mm.

Maturing.—The largest eggs are fully opaque, with diameters ranging roughly from 0.40 to 1.00 mm.

Ripe.—The largest eggs are transparent and loose, with diameters of about 0.76 to 1.23 mm. A prominent oil globule is present in each egg.

The ovaries collected after 1951 were subjected to an added procedure in the laboratory. They were examined for residual eggs—ripe eggs of a previous spawning that were not expelled. These eggs were classified as being in the early stages of resorption if they were still translucent and loose, and as being in the late stages if they were massed together and opaque or turning opaque.

The laboratory classifications of the ovaries are arranged in table 1 by month and locality of capture, by stage of maturity, and by length of fish.

TABLE 1.—*Data on 740 yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the laboratory*

[Data are grouped by month of capture, by sections of 10 degrees of longitude (115° W. to 125° W., etc.), by stage of maturity, and by fish length]
[Im=immature, In=intermediate, M=mature, R=ripe]

Date	Position		Stage of maturity	Fish length	Date	Position		Stage of maturity	Fish length
	Latitude	Longitude				Latitude	Longitude		
				Cm.					*Cm.*
Jan. 26, 1951	5°37′ S.	154°56′ W.	M	113	Feb. 10, 1951	0°22′ S.	160°01′ W.	Im	110
Jan. 27, 1951	4°03′ S.	154°59′ W.	Im	104	Feb. 5, 1953	3°51′ N.	159°26′ W.	Im	107
Do	4°03′ S.	154°59′ W.	Im	96	Do	3°51′ N.	159°26′ W.	Im	105
Jan. 26, 1951	5°37′ S.	154°56′ W.	Im	78	Feb. 3, 1953	1°59′ N.	157°31′ W.	Im	104
Jan. 31, 1953	1°52′ N.	156°41′ W.	M	143	Feb. 16, 1951	0°22′ S.	160°01′ W.	Im	91
Do	1°52′ N.	156°41′ W.	In	146	Feb. 21, 1951	5°53′ N.	162°05′ W.	Im	90
Jan. 23, 1953	5°55′ N.	162°19′ W.	In	135	Feb. 11, 1951	0°22′ S.	160°01′ W.	Im	86
Do	5°55′ N.	162°19′ W.	In	132	Feb. 21, 1951	5°53′ N.	162°05′ W.	Im	85
Jan. 25, 1953	5°46′ N.	162°06′ W.	In	127	Feb. 4, 1951	3°52′ N.	159°20′ W.	Im	83
Do	5°46′ N.	162°06′ W.	Im	133	Feb. 21, 1951	5°53′ N.	162°05′ W.	Im	81
Do	5°46′ N.	162°06′ W.	Im	119	Feb. 16, 1951	1°51′ N.	157°20′ W.	Im	75
Jan. 21, 1951	0°01′ N.	158°17′ W.	Im	85	Feb. 17, 1951	3°52′ N.	159°20′ W.	Im	75
Jan. 19, 1951	8°30′ N.	158°21′ W.	Im	83	Feb. 19, 1951	3°52′ N.	159°20′ W.	Im	74
Jan. 27, 1953	5°53′ N.	161°15′ W.	Im	66	Feb. 22, 1951	5°53′ N.	162°05′ W.	Im	74
Jan. 26, 1951	3°07′ S.	171°05′ W.	In	98	Feb. 12, 1951	3°52′ N.	159°20′ W.	Im	73
Jan. 31, 1951	3°35′ S.	171°31′ W.	In	93	Feb. 13, 1951	1°51′ N.	157°20′ W.	Im	72
Jan. 26, 1951	3°07′ S.	171°05′ W.	Im	91	Feb. 8, 1950	4°30′ S.	172°10′ W.	M	120
Do	3°07′ S.	171°05′ W.	Im	78	Feb. 5, 1951	3°07′ S.	171°05′ W.	M	108
Jan. 29, 1951	4°26′ S.	171°15′ W.	Im	68	Feb. 11, 1950	2°50′ S.	171°40′ W.	Im	128
Feb. 11, 1953	0°09′ N.	150°00′ W.	M	149	Feb. 10, 1952	3°15′ S.	171°30′ W.	Im	80
Feb. 4, 1953	2°07′ N.	150°09′ W.	M	148	Feb. 8, 1950	4°30′ S.	172°10′ W.	Im	78
Feb. 4, 1952	0°02′ S.	154°57′ W.	M	147	Feb. 5, 1951	3°07′ S.	171°05′ W.	Im	67
Feb. 14, 1953	1°19′ S.	150°36′ W.	M	146	Feb. 18, 1952	0°02′ N.	179°48′ E.	M	144
Feb. 12, 1953	1°13′ S.	150°11′ W.	M	145	Do	0°02′ N.	179°48′ E.	M	142
Feb. 4, 1953	2°07′ N.	150°09′ W.	M	143	Feb. 20, 1952	2°39′ S.	179°54′ E.	M	140
Feb. 12, 1953	1°13′ S.	150°11′ W.	M	143	Feb. 21, 1952	4°03′ S.	179°58′ E.	M	140
Feb. 13, 1953	1°19′ S.	150°24′ W.	M	143	Feb. 20, 1952	2°39′ S.	179°54′ E.	M	138
Feb. 4, 1953	2°07′ N.	150°09′ W.	M	139	Feb. 21, 1952	4°03′ S.	179°58′ E.	M	138
Do	2°07′ N.	150°09′ W.	M	138	Feb. 16, 1952	3°00′ N.	180°00′	M	133
Feb. 12, 1953	1°13′ S.	150°11′ W.	M	138	Feb. 19, 1952	1°18′ S.	180°00′	M	130
Do	1°13′ S.	150°11′ W.	M	138	Do	1°18′ S.	180°00′	M	126
Feb. 13, 1953	1°19′ S.	150°24′ W.	M	137	Feb. 23, 1952	6°47′ S.	179°59′ W.	In	134
Feb. 4, 1952	0°02′ S.	154°57′ W.	M	135	Feb. 24, 1952	8°00′ S.	179°56′ E.	In	132
Feb. 3, 1953	2°54′ N.	150°19′ W.	In	152	Mar. 15, 1953	1°00′ N.	140°00′ W.	R	146
Feb. 13, 1953	1°19′ S.	150°24′ W.	In	150	Do	1°00′ N.	140°00′ W.	R	143
Feb. 4, 1952	0°02′ S.	154°57′ W.	In	148 or 140	Mar. 12, 1953	1°51′ S.	140°11′ W.	R	141
Feb. 4, 1953	2°07′ N.	150°09′ W.	In	142	Mar. 11, 1953	1°48′ S.	139°59′ W.	M	168
Feb. 13, 1953	1°19′ S.	150°24′ W.	In	142	Mar. 15, 1953	1°00′ N.	140°00′ W.	M	153
Feb. 3, 1953	2°54′ N.	150°19′ W.	In	141	Mar. 13, 1953	1°00′ S.	140°05′ W.	M	152
Feb. 10, 1953	1°04′ N.	151°05′ W.	In	141	Mar. 15, 1953	1°00′ N.	140°00′ W.	M	149
Feb. 1, 1952	4°04′ N.	154°56′ W.	In	140	Mar. 18, 1953	4°12′ N.	140°20′ W.	M	149
Feb. 17, 1953	2°56′ S.	150°08′ W.	In	138	Mar. 14, 1953	0°09′ N.	139°47′ W.	M	148
Feb. 2, 1953	3°49′ N.	150°07′ W.	In	136	Do	0°09′ N.	139°47′ W.	M	146
Feb. 1, 1952	4°04′ N.	154°56′ W.	In	129	Mar. 8, 1953	6°16′ S.	141°32′ W.	M	145
Do	4°04′ N.	154°56′ W.	In	128	Mar. 13, 1953	1°00′ S.	140°05′ W.	M	144
Feb. 2, 1953	3°49′ N.	150°07′ W.	Im	140	Do	1°00′ S.	140°05′ W.	M	144
Feb. 19, 1953	6°08′ S.	150°09′ W.	Im	136	Mar. 17, 1953	3°07′ N.	140°07′ W.	M	144
Feb. 1, 1952	4°04′ N.	154°56′ W.	Im	126	Mar. 16, 1953	2°12′ N.	140°18′ W.	M	143
Do	4°04′ N.	154°56′ W.	Im	123	Mar. 10, 1953	3°25′ S.	140°03′ W.	M	142
Do	4°04′ N.	154°56′ W.	Im	118	Mar. 14, 1953	0°09′ N.	139°47′ W.	M	142
Do	4°04′ N.	154°56′ W.	Im	114	Mar. 16, 1953	2°12′ N.	140°18′ W.	M	142
Do	4°04′ N.	154°56′ W.	Im	108	Mar. 17, 1953	3°07′ N.	140°07′ W.	M	142
Feb. 5, 1952	1°20′ S.	155°06′ W.	M	148	Mar. 11, 1953	1°48′ S.	139°59′ W.	M	141
Feb. 3, 1953	1°59′ N.	157°31′ W.	M	148	Mar. 13, 1953	1°00′ S.	140°05′ W.	M	141
Feb. 5, 1952	1°20′ S.	155°06′ W.	M	147	Mar. 15, 1953	1°00′ N.	140°00′ W.	M	141
Do	1°20′ S.	155°06′ W.	M	143	Do	1°00′ N.	140°00′ W.	M	140
Feb. 3, 1952	1°20′ N.	155°03′ W.	M	142	Mar. 18, 1953	4°12′ N.	140°20′ W.	M	140
Feb. 5, 1952	1°20′ S.	155°06′ W.	M	139	Do	4°12′ N.	140°20′ W.	M	140
Feb. 3, 1953	1°59′ N.	157°31′ W.	M	139	Mar. 16, 1953	2°12′ N.	140°18′ W.	M	139
Do	1°59′ N.	157°31′ W.	M	138	Do	2°12′ N.	140°18′ W.	M	139
Do	1°59′ N.	157°31′ W.	M	134	Mar. 17, 1953	3°07′ N.	140°07′ W.	M	139
Feb. 1, 1953	1°57′ N.	157°32′ W.	M	133	Mar. 14, 1953	0°09′ N.	139°47′ W.	M	136
Feb. 3, 1953	1°59′ N.	157°31′ W.	M	130	Mar. 8, 1953	6°16′ S.	141°32′ W.	M	135
Feb. 3, 1952	1°20′ N.	155°03′ W.	M	126	Mar. 13, 1953	1°00′ S.	140°05′ W.	M	135
Feb. 3, 1953	1°59′ N.	157°31′ W.	M	124	Mar. 12, 1953	1°51′ S.	140°11′ W.	M	134
Feb. 5, 1952	1°20′ S.	155°06′ W.	M	76	Mar. 17, 1953	3°07′ N.	140°07′ W.	M	134
Feb. 1, 1953	1°57′ N.	157°32′ W.	In	142	Mar. 16, 1953	2°12′ N.	140°18′ W.	M	133
Feb. 5, 1952	1°20′ S.	155°06′ W.	In	140	Mar. 18, 1953	4°12′ N.	140°20′ W.	In	143
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	140	Mar. 4, 1953	13°31′ S.	147°08′ W.	M	140
Do	1°59′ N.	157°31′ W.	In	138	Do	13°31′ S.	147°08′ W.	Im	74
Feb. 5, 1952	1°20′ S.	155°06′ W.	In	137	Mar. 12, 1952	4°10′ N.	168°30′ W.	R	145
Feb. 2, 1952	2°46′ N.	155°10′ W.	In	136	Mar. 4, 1952	6°40′ S.	169°03′ W.	M	146
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	136	Do	6°40′ S.	169°03′ W.	M	143
Feb. 1, 1953	1°57′ N.	157°32′ W.	In	135	Mar. 8, 1952	1°20′ S.	169°00′ W.	M	143
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	135	Mar. 5, 1952	5°18′ S.	169°03′ W.	M	142
Feb. 5, 1953	3°51′ N.	159°26′ W.	In	134	Mar. 10, 1952	1°20′ N.	169°05′ W.	M	142
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	133	Mar. 9, 1952	0°01′ N.	169°04′ W.	M	141
Feb. 6, 1952	2°42′ N.	155°05′ W.	In	132	Mar. 8, 1952	1°20′ S.	169°00′ W.	M	140
Feb. 1, 1953	1°57′ N.	157°32′ W.	In	131	Mar. 11, 1952	2°50′ N.	169°07′ W.	M	140
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	131	Do	2°50′ N.	169°07′ W.	M	139
Feb. 6, 1952	2°42′ N.	155°05′ W.	In	130	Mar. 4, 1952	6°40′ S.	169°03′ W.	M	135
Feb. 1, 1953	1°57′ N.	157°32′ W.	In	130	Mar. 9, 1952	0°01′ N.	169°04′ W.	M	132
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	130	Mar. 7, 1952	2°43′ S.	169°00′ W.	M	130
Feb. 4, 1951	3°52′ N.	159°20′ W.	In	98	Mar. 10, 1952	1°20′ N.	169°05′ W.	M	130
Feb. 5, 1953	3°51′ N.	159°26′ W.	Im	123	Mar. 11, 1952	2°50′ N.	169°07′ W.	In	141
Feb. 3, 1953	1°59′ N.	157°31′ W.	Im	120	Mar. 6, 1952	4°02′ S.	169°04′ W.	In	126
Feb. 11, 1951	0°22′ S.	160°01′ W.	Im	112	Apr. 30, 1951	1°51′ N.	157°20′ W.	M	110

TABLE 1.—*Data on 740 yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the laboratory*—Continued

Date	Position		Stage of maturity	Fish length
	Latitude	Longitude		
				Cm.
Apr. 26, 1951	1°51′ N.	157°20′ W.	M	98
Apr. 27, 1951	1°51′ N.	157°20′ W.	In	108
Do	1°51′ N.	157°20′ W.	In	96
Apr. 30, 1951	1°51′ N.	157°20′ W.	In	96
Apr. 26, 1951	1°51′ N.	157°20′ W.	In	81
Apr. 18, 1951	5°53′ N.	162°05′ W.	Im	110
Apr. 16, 1951	5°53′ N.	162°05′ W.	Im	104
Apr. 11, 1951	0°22′ S.	160°01′ W.	Im	98
Apr. 13, 1951	5°53′ N.	162°05′ W.	Im	98
Apr. 16, 1950	5°53′ N.	162°05′ W.	Im	98
Apr. 15, 1951	5°53′ N.	162°05′ W.	Im	92
Apr. 16, 1951	5°53′ N.	162°05′ W.	Im	90
Apr. 24, 1951	1°51′ N.	157°20′ W.	Im	80
Apr. 26, 1951	1°51′ N.	157°20′ W.	Im	80
Apr. 27, 1951	1°51′ N.	157°20′ W.	Im	80
Apr. 26, 1951	1°51′ N.	157°20′ W.	Im	75
Apr. 13, 1951	5°53′ N.	162°05′ W.	Im	70
May 29, 1952	7°09′ N.	119°00′ W.	R	148
May 31, 1952	4°18′ N.	119°35′ W.	M	146
Do	4°18′ N.	119°35′ W.	M	146
Do	4°18′ N.	119°35′ W.	M	135
May 23, 1954	4°55′ N.	161°19′ W.	M	151
May 28, 1954	4°02′ N.	159°34′ W.	M	146
Do	4°02′ N.	159°34′ W.	M	146
Do	4°02′ N.	159°34′ W.	M	143
May 23, 1954	4°55′ N.	161°19′ W.	M	140
May 30, 1954	3°58′ N.	159°04′ W.	M	140
May 7, 1951	3°52′ N.	159°20′ W.	M	136
May 13, 1950	1°51′ N.	157°20′ W.	M	136
May 25, 1954	4°45′ N.	160°11′ W.	M	134
May 23, 1954	4°55′ N.	161°19′ W.	M	133
May 26, 1954	4°52′ N.	159°35′ W.	M	133
May 18, 1954	6°02′ N.	162°28′ W.	M	130
May 22, 1954	5°26′ N.	161°37′ W.	M	129
May 23, 1954	4°55′ N.	161°19′ W.	M	129
May 31, 1951	6°25′ N.	162°26′ W.	M	127
May 24, 1954	4°56′ N.	160°32′ W.	M	123
May 25, 1954	4°45′ N.	160°11′ W.	M	122
May 27, 1954	4°17′ N.	160°28′ W.	M	121
May 28, 1954	4°02′ N.	159°34′ W.	M	117
May 27, 1954	4°17′ N.	160°28′ W.	M	114
May 31, 1951	6°25′ N.	162°26′ W.	M	106
Do	6°25′ N.	162°26′ W.	M	101
Do	6°25′ N.	162°26′ W.	M	100
Do	6°25′ N.	162°26′ W.	M	92
Do	6°25′ N.	126°26′ W.	M	92
May 1, 1951	1°51′ N.	157°20′ W.	M	86
May 26, 1954	4°52′ N.	159°35′ W.	In	128
May 28, 1954	4°02′ N.	159°34′ W.	In	122
May 25, 1954	4°45′ N.	160°11′ W.	In	121
May 28, 1950	5°53′ N.	162°05′ W.	In	118
May 30, 1954	3°58′ N.	159°04′ W.	In	117
May 3, 1950	4°42′ N.	160°24′ W.	In	115
May 31, 1950	6°25′ N.	162°26′ W.	In	115
May 30, 1954	3°58′ N.	159°04′ W.	In	114
May 27, 1954	4°17′ N.	160°28′ W.	In	110
May 29, 1950	6°25′ N.	162°26′ W.	In	109
May 30, 1954	3°58′ N.	159°04′ W.	In	108
May 12, 1950	1°51′ N.	157°20′ W.	In	107
May 17, 1954	5°58′ N.	162°52′ W.	In	106
May 11, 1951	5°53′ N.	162°05′ W.	In	104
May 30, 1954	3°58′ N.	159°04′ W.	In	104
May 1, 1951	1°51′ N.	157°20′ W.	In	100
May 31, 1951	6°25′ N.	162°26′ W.	In	100
May 1, 1951	1°51′ N.	157°20′ W.	In	98
May 30, 1954	3°58′ N.	159°04′ W.	In	98
May 30, 1951	6°25′ N.	162°26′ W.	In	94
May 12, 1951	6°25′ N.	162°26′ W.	In	92
May 30, 1951	6°25′ N.	162°26′ W.	In	90
May 31, 1951	6°25′ N.	162°26′ W.	In	90
May 30, 1951	6°25′ N.	162°26′ W.	In	89
May 31, 1951	6°25′ N.	162°26′ W.	In	88
Do	6°25′ N.	162°26′ W.	In	88
Do	6°25′ N.	162°26′ W.	In	88
May 28, 1950	6°25′ N.	162°26′ W.	In	85
May 31, 1951	6°25′ N.	162°26′ W.	In	82
May 17, 1954	5°58′ N.	162°52′ W.	Im	149
May 31, 1950	6°25′ N.	162°26′ W.	Im	115
May 27, 1950	5°53′ N.	162°05′ W.	Im	112
May 3, 1950	4°42′ N.	160°24′ W.	Im	111
May 17, 1954	5°58′ N.	162°52′ W.	Im	111
May 3, 1950	4°42′ N.	160°24′ W.	Im	108
Do	4°42′ N.	160°24′ W.	Im	104
May 30, 1954	3°58′ N.	159°04′ W.	Im	103
May 28, 1954	4°02′ N.	159°34′ W.	Im	102
May 17, 1954	5°58′ N.	162°52′ W.	Im	101
May 28, 1954	4°02′ N.	159°34′ W.	Im	101
May 30, 1954	3°58′ N.	159°04′ W.	Im	101
May 17, 1954	5°58′ N.	162°52′ W.	Im	100
May 30, 1951	6°25′ N.	162°26′ W.	Im	96
May 28, 1954	4°02′ N.	159°34′ W.	Im	93
May 30, 1951	6°25′ N.	162°26′ W.	Im	90
May 20, 1951	6°25′ N.	162°26′ W.	Im	88
May 24, 1954	4°56′ N.	160°32′ W.	Im	88
May 30, 1951	6°25′ N.	162°26′ W.	Im	88
Do	6°25′ N.	162°26′ W.	Im	87
Do	6°25′ N.	162°26′ W.	Im	86
Do	6°25′ N.	162°26′ W.	Im	86
May 31, 1951	6°25′ N.	162°26′ W.	Im	85
May 1, 1951	1°51′ N.	157°20′ W.	Im	83
Do	1°51′ N.	157°20′ W.	Im	82
Do	1°51′ N.	157°20′ W.	Im	81
Do	1°51′ N.	157°20′ W.	Im	80
Do	1°51′ N.	157°20′ W.	Im	80
May 7, 1951	3°52′ N.	159°20′ W.	Im	79
May 3, 1950	4°42′ N.	160°24′ W.	Im	75
May 11, 1951	6°25′ N.	162°26′ W.	Im	75
Do	6°25′ N.	162°26′ W.	Im	75
May 27, 1950	5°53′ N.	162°05′ W.	Im	74
Do	6°25′ N.	162°26′ W.	Im	74
May 30, 1953	4°26′ S.	170°09′ W.	R	134
May 31, 1953	3°27′ S.	170°12′ W.	M	149
May 28, 1953	6°51′ S.	170°02′ W.	M	148
May 30, 1953	4°26′ S.	170°09′ W.	M	144
Do	4°26′ S.	170°09′ W.	M	136
Do	4°26′ S.	170°09′ W.	M	136
Do	4°26′ S.	170°09′ W.	M	133
May 29, 1953	5°41′ S.	169°44′ W.	M	103
May 30, 1953	4°26′ S.	170°09′ W.	In	130
Do	4°26′ S.	170°09′ W.	Im	94
June 3, 1952	0°19′ N.	119°58′ W.	M	157
June 12, 1952	6°06′ N.	129°55′ W.	R	156
June 9, 1952	2°19′ N.	130°07′ W.	R	150
June 12, 1952	6°06′ N.	129°55′ W.	R	142
June 13, 1952	8°00′ N.	130°24′ W.	R	139
June 12, 1952	6°06′ N.	129°55′ W.	R	129
June 13, 1952	8°00′ N.	130°24′ W.	R	94
June 6, 1952	1°01′ S.	125°56′ W.	M	153
June 8, 1952	0°21′ N.	129°23′ W.	M	153
June 9, 1952	2°19′ N.	130°07′ W.	M	146
Do	2°19′ N.	130°07′ W.	M	135
Do	2°19′ N.	130°07′ W.	Im	142
June 1, 1951	6°25′ N.	162°26′ W.	R	90
June 7, 1954	1°52′ N.	156°47′ W.	M	152
June 2, 1954	2°29′ N.	158°22′ W.	M	147
June 1, 1954	3°04′ N.	159°13′ W.	M	146
June 9, 1954	1°47′ N.	158°16′ W.	M	142
June 1, 1954	3°04′ N.	159°13′ W.	M	140
June 2, 1954	2°29′ N.	158°22′ W.	M	138
June 7, 1954	1°52′ N.	156°47′ W.	M	126
June 1, 1951	6°25′ N.	162°26′ W.	M	118
June 5, 1950	4°42′ N.	160°24′ W.	M	99
June 1, 1951	6°25′ N.	162°26′ W.	M	90
Do	5°53′ N.	162°05′ W.	M	87
Do	5°53′ N.	162°05′ W.	M	84
Do	5°53′ N.	162°05′ W.	M	83
June 9, 1954	1°47′ N.	158°16′ W.	In	128
June 1, 1954	3°04′ N.	159°13′ W.	In	118
June 7, 1954	1°52′ N.	156°47′ W.	In	115
June 4, 1954	2°03′ N.	157°40′ W.	In	114
Do	2°03′ N.	157°40′ W.	In	112
June 1, 1954	3°04′ N.	159°13′ W.	In	110
June 4, 1950	4°42′ N.	160°24′ W.	In	110
June 8, 1954	2°01′ N.	157°09′ W.	In	108
June 4, 1954	2°03′ N.	157°40′ W.	In	100
June 8, 1954	2°01′ N.	157°09′ W.	Im	120
June 7, 1954	1°52′ N.	156°47′ W.	Im	110
June 4, 1950	4°42′ N.	160°24′ W.	Im	100
June 8, 1954	2°01′ N.	157°09′ W.	Im	94
June 6, 1951	3°52′ N.	159°20′ W.	Im	85
Do	3°52′ N.	159°20′ W.	Im	83
Do	3°52′ N.	159°20′ W.	Im	83
June 4, 1950	4°42′ N.	160°24′ W.	Im	82
June 6, 1951	3°52′ N.	159°20′ W.	Im	82
Do	3°52′ N.	159°20′ W.	Im	82
Do	3°52′ N.	159°20′ W.	Im	80
June 1, 1951	5°53′ N.	162°05′ W.	Im	77
Do	5°53′ N.	162°05′ W.	Im	76
Do	5°53′ N.	162°05′ W.	Im	76
June 3, 1950	5°53′ N.	162°05′ W.	Im	75
June 2, 1953	0°30′ S.	169°52′ W.	R	138
June 1, 1953	2°14′ S.	170°00′ W.	M	142
June 2, 1953	0°30′ S.	169°52′ W.	M	141
Do	0°30′ S.	169°52′ W.	M	133
Do	0°30′ S.	169°52′ W.	M	131
June 1, 1953	2°14′ S.	170°00′ W.	M	129
June 2, 1953	0°30′ S.	169°52′ W.	M	121
June 1, 1953	2°14′ S.	170°00′ W.	M	102
June 12, 1951	2°50′ S.	171°40′ W.	Im	135
June 17, 1951	2°50′ S.	171°40′ W.	Im	122

TABLE 1.—*Data on 740 yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the laboratory*—Continued

Date	Position		Stage of maturity	Fish length
	Latitude	Longitude		
				Cm.
June 17, 1951	2°50′ S.	171°40′ W.	Im	118
June 1, 1953	2°14′ S.	170°00′ W.	Im	81
July 17, 1950	2°50′ S.	171°40′ W.	M	140
July 15, 1950	2°50′ S.	171°40′ W.	M	128
July 19, 1950	2°50′ S.	171°40′ W.	In	134
Do	2°50′ S.	171°40′ W.	Im	118
Aug. 24, 1952	4°28′ N.	139°51′ W.	M	156
Aug. 23, 1952	5°16′ N.	140°28′ W.	M	151
Aug. 24, 1952	4°28′ N.	139°51′ W.	M	151
Aug. 31, 1952	3°45′ N.	140°10′ W.	M	151
Aug. 26, 1952	2°23′ N.	140°12′ W.	M	146
Aug. 31, 1952	3°45′ N.	140°10′ W.	M	143
Aug. 28, 1952	1°00′ N.	140°22′ W.	M	139
Aug. 24, 1952	4°28′ N.	139°51′ W.	M	129
Aug. 21, 1952	7°02′ N.	140°46′ W.	M	124
Aug. 23, 1952	5°16′ N.	140°28′ W.	M	121
Aug. 28, 1952	1°00′ N.	140°22′ W.	In	157
Aug. 29, 1952	2°00′ N.	140°40′ W.	In	153 or 139
Aug. 27, 1952	1°33′ N.	140°13′ W.	In	147
Aug. 31, 1952	3°45′ N.	140°10′ W.	In	142
Aug. 26, 1952	2°23′ N.	140°12′ W.	In	141
Aug. 29, 1952	2°00′ N.	140°40′ W.	In	139
Aug. 13, 1953	0°08′ N.	154°51′ W.	M	168
Do	0°08′ N.	154°51′ W.	M	143
Do	0°08′ N.	154°51′ W.	M	143
Aug. 27, 1951	9°36′ N.	150°06′ W.	M	143 or 131
Aug. 13, 1953	0°08′ N.	154°51′ W.	M	142
Do	0°08′ N.	154°51′ W.	M	141
Do	0°08′ N.	154°51′ W.	M	138
Aug. 26, 1953	7°50′ N.	159°24′ W.	M	153
Aug. 16, 1953	4°10′ S.	155°33′ W.	M	151
Aug. 12, 1953	1°21′ N.	155°16′ W.	M	148
Aug. 19, 1953	1°31′ S.	159°53′ W.	M	144
Aug. 7, 1953	2°05′ N.	157°38′ W.	M	143
Do	2°05′ N.	157°38′ W.	M	142
Aug. 21, 1953	1°11′ N.	160°08′ W.	M	142
Aug. 25, 1953	6°10′ N.	160°02′ W.	M	142
Aug. 7, 1953	2°05′ N.	157°38′ W.	M	141
Aug. 20, 1953	0°01′ N.	159°56′ W.	M	141
Aug. 21, 1953	1°11′ N.	160°08′ W.	M	141
Do	1°11′ N.	160°08′ W.	M	141
Do	1°11′ N.	160°08′ W.	M	140
Do	1°11′ N.	160°08′ W.	M	140
Aug. 19, 1953	1°31′ S.	159°53′ W.	M	139
Aug. 25, 1953	6°10′ N.	160°02′ W.	M	139
Aug. 7, 1953	2°05′ N.	157°38′ W.	M	138
Aug. 12, 1953	1°21′ N.	155°16′ W.	M	136
Do	1°21′ N.	155°16′ W.	M	136
Aug. 19, 1953	1°31′ S.	159°53′ W.	M	136
Aug. 20, 1953	0°01′ N.	159°56′ W.	M	136
Aug. 7, 1953	2°05′ N.	157°38′ W.	M	135
Do	2°05′ N.	157°38′ W.	M	135
Aug. 12, 1953	1°21′ N.	155°16′ W.	M	135
Aug. 14, 1953	1°08′ S.	155°18′ W.	M	134
Aug. 19, 1953	1°31′ S.	159°53′ W.	M	134
Aug. 23, 1953	3°22′ N.	160°24′ W.	M	128
Aug. 7, 1953	2°05′ N.	157°38′ W.	M	126
Do	2°05′ N.	157°38′ W.	M	124
Aug. 25, 1950	6°25′ N.	162°26′ W.	M	111
Aug. 14, 1953	1°08′ S.	155°18′ W.	In	147
Aug. 19, 1953	1°31′ S.	159°53′ W.	In	142
Aug. 14, 1953	1°08′ S.	155°18′ W.	In	140
Aug. 16, 1953	4°10′ S.	155°33′ W.	In	139
Aug. 14, 1953	1°08′ S.	155°18′ W.	In	138
Aug. 18, 1953	2°56′ S.	160°14′ W.	In	138
Aug. 19, 1953	1°31′ S.	159°53′ W.	In	138
Do	1°31′ S.	159°53′ W.	In	136
Aug. 14, 1953	1°08′ S.	155°18′ W.	In	134
Aug. 18, 1953	2°56′ S.	160°14′ W.	In	132
Aug. 14, 1953	1°08′ S.	155°18′ W.	In	131
Aug. 21, 1953	1°11′ N.	160°08′ W.	In	127
Aug. 19, 1953	1°31′ S.	159°53′ W.	In	125
Aug. 21, 1953	1°11′ N.	160°08′ W.	In	111
Aug. 15, 1953	2°33′ S.	155°23′ W.	In	89
Aug. 18, 1953	2°56′ S.	160°14′ W.	Im	139
Aug. 20, 1953	0°01′ N.	159°56′ W.	Im	116
Aug. 21, 1953	1°11′ N.	160°08′ W.	Im	109
Aug. 14, 1953	1°08′ S.	155°18′ W.	Im	104
Aug. 25, 1953	6°10′ N.	160°02′ W.	Im	102
Aug. 18, 1953	2°56′ S.	160°14′ W.	Im	89
Aug. 16, 1950	3°35′ S.	171°31′ W.	M	118
Do	3°35′ S.	171°31′ W.	Im	114
Aug. 17, 1950	3°07′ S.	171°05′ W.	Im	85
Do	3°07′ S.	171°05′ W.	Im	66
Do	3°07′ S.	171°05′ W.	Im	64
Sept. 6, 1952	2°06′ N.	140°56′ W.	R	155
Sept. 9, 1952	2°33′ N.	143°22′ W.	R	136
Sept. 7, 1952	1°42′ N.	141°24′ W.	M	153
Sept. 9, 1952	2°33′ N.	143°22′ W.	M	148
Do	2°33′ N.	143°22′ W.	M	147

Date	Position		Stage of maturity	Fish length
	Latitude	Longitude		
				Cm.
Sept. 3, 1952	4°04′ N.	140°09′ W.	M	146
Sept. 6, 1952	2°06′ N.	140°56′ W.	M	144
Sept. 7, 1952	1°42′ N.	141°24′ W.	M	144
Do	1°43′ N.	141°24′ W.	M	139
Sept. 2, 1952	3°05′ N.	140°02′ W.	In	152
Sept. 6, 1952	2°06′ N.	140°56′ W.	In	148
Sept. 2, 1952	3°05′ N.	140°02′ W.	In	146
Sept. 4, 1952	3°20′ N.	140°10′ W.	In	144
Sept. 7, 1952	1°42′ N.	141°24′ W.	In	140
Sept. 1, 1952	3°31′ N.	140°28′ W.	In	138
Sept. 2, 1952	3°05′ N.	140°02′ W.	In	137
Sept. 4, 1952	3°20′ N.	140°10′ W.	Im	149
Sept. 5, 1951	2°02′ N.	151°50′ W.	R	142
Sept. 13, 1952	1°22′ N.	149°54′ W.	R	137
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	153
Sept. 13, 1952	1°22′ N.	149°54′ W.	M	153
Sept. 16, 1952	2°28′ N.	150°38′ W.	M	152
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	148
Sept. 15, 1952	2°05′ N.	150°23′ W.	M	148
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	148
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	147
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	147
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	146
Sept. 13, 1951	2°02′ N.	153-12′ W.	M	146
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	146
Sept. 20, 1951	0°54′ N.	150°00′ W.	M	146
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	145
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	145
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	144
Do	2°57′ N.	150°17′ W.	M	143
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	143
Sept. 6, 1951	2°03′ N.	153°12′ W.	M	143
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	143
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	142
Do	1°59′ N.	150°12′ W.	M	142
Sept. 17, 1951	2°01′ N.	154°50′ W.	M	142
Sept. 18, 1951	2°02′ N.	153°12′ W.	M	142
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	142
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	141
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	141
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	141
Do	2°02′ N.	151°50′ W.	M	141
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	141
Do	2°00′ N.	151°24′ W.	M	141
Sept. 20, 1951	0°54′ N.	150°00′ W.	M	141
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	140
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	140
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	140
Do	2°00′ N.	151°24′ W.	M	140
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	139
Do	4°04′ N.	150°06′ W.	M	139
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	139
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	139
Do	2°00′ N.	151°24′ W.	M	139
Sept. 20, 1951	0°54′ N.	150°00′ W.	M	139
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	138
Do	4°04′ N.	150°06′ W.	M	138
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	138
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	138
Sept. 13, 1952	1°22′ N.	149°54′ W.	M	138
Sept. 17, 1951	2°01′ N.	154°50′ W.	M	138
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	138
Sept. 20, 1951	0°54′ N.	150°00′ W.	M	138
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	137
Sept. 6, 1951	2°03′ N.	153°12′ W.	M	137
Do	2°03′ N.	153°12′ W.	M	137
Sept. 18, 1951	2°02′ N.	153°12′ W.	M	137
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	136
Do	4°04′ N.	150°06′ W.	M	136
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	136
Sept. 16, 1952	2°28′ N.	150°38′ W.	M	136
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	135
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	135
Sept. 18, 1951	2°02′ N.	153°12′ W.	M	135
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	134
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	133
Do	2°02′ N.	151°50′ W.	M	133
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	132
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	131
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	131
Sept. 6, 1951	2°03′ N.	153°12′ W.	M	131
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	129
Sept. 17, 1952	3°26′ N.	151°40′ W.	M	129
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	128
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	115
Sept. 18, 1951	2°02′ N.	153°12′ W.	M	106
Sept. 17, 1951	2°01′ N.	154°50′ W.	M	75
Sept. 19, 1951	2°00′ N.	151°24′ W.	In	143
Sept. 17, 1951	2°01′ N.	154°50′ W.	In	142
Sept. 19, 1951	2°00′ N.	151°24′ W.	In	142

TABLE 1.—*Data on 740 yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the laboratory*—Continued

Date	Position		Stage of maturity	Fish length
	Latitude	Longitude		
				Cm.
Sept. 22, 1951	1°07′ S.	150°21′ W.	In	142
Sept. 17, 1951	2°01′ N.	154°50′ W.	In	141
Do	2°01′ N.	154°50′ W.	In	141
Do	2°01′ N.	154°50′ W.	In	140
Do	2°01′ N.	154°50′ W.	In	140
Sept. 19, 1951	2°00′ N.	151°24′ W.	In	140
Sept. 17, 1951	2°01′ N.	154°50′ W.	In	139
Do	2°01′ N.	154°50′ W.	In	139
Sept. 20, 1951	0°54′ N.	150°00′ W.	In	139
Sept. 19, 1951	2°00′ N.	151°24′ W.	In	138
Sept. 17, 1951	2°01′ N.	154°50′ W.	In	137
Sept. 4, 1951	1°59′ N.	150°12′ W.	In	136
Sept. 17, 1951	2°01′ N.	154°50′ W.	In	134
Sept. 25, 1951	4°56′ S.	150°13′ W.	In	133
Sept. 17, 1951	2°01′ N.	154°50′ W.	In	131
Do	2°01′ N.	154°50′ W.	In	131
Sept. 18, 1951	2°02′ N.	153°12′ W.	In	129
Sept. 17, 1951	2°01′ N.	154°50′ W.	In	128
Sept. 2, 1951	4°04′ N.	150°06′ W.	In	127
Sept. 25, 1951	4°56′ S.	150°13′ W.	In	122
Do	4°56′ S.	150°13′ W.	Im	117
Sept. 12, 1951	1°52′ N.	155°24′ W.	M	144
Sept. 15, 1951	1°19′ N.	157°30′ W.	M	143
Sept. 12, 1951	1°52′ N.	155°24′ W.	M	138
Do	1°52′ N.	155°24′ W.	M	137
Sept. 16, 1951	1°52′ N.	156°24′ W.	M	133
Sept. 14, 1951	1°59′ N.	157°36′ W.	M	113
Sept. 12, 1951	1°52′ N.	155°24′ W.	In	144
Sept. 13, 1951	2°02′ N.	156°20′ W.	In	144
Do	2°02′ N.	156°20′ W.	In	144
Sept. 12, 1951	1°52′ N.	155°24′ W.	In	142
Sept. 13, 1951	2°02′ N.	156°20′ W.	In	141
Sept. 16, 1951	1°52′ N.	156°24′ W.	In	140
Sept. 13, 1951	2°02′ N.	156°20′ W.	In	136
Do	2°02′ N.	156°20′ W.	In	136
Do	2°02′ N.	156°20′ W.	In	136
Sept. 16, 1951	1°52′ N.	156°24′ W.	In	136
Sept. 13, 1951	2°02′ N.	156°20′ W.	In	135
Sept. 12, 1951	1°52′ N.	155°24′ W.	In	133
Sept. 15, 1951	1°19′ N.	157°30′ W.	In	124
Sept. 13, 1951	2°02′ N.	156°20′ W.	In	115
Sept. 14, 1951	1°59′ N.	157°36′ W.	In	114
Do	1°59′ N.	157°36′ W.	In	109
Do	1°59′ N.	157°36′ W.	In	93
Do	1°59′ N.	157°36′ W.	Im	104
Do	1°59′ N.	157°36′ W.	Im	96
Oct. 19, 1952	8°14′ N.	120°32′ W.	R	147
Oct. 30, 1952	3°58′ S.	120°14′ W.	In	133
Oct. 31, 1952	5°36′ S.	120°25′ W.	Im	159
Oct. 27, 1952	5°34′ N.	152°26′ W.	M	143
Oct. 29, 1952	3°12′ N.	152°05′ W.	M	135
Oct. 27, 1952	5°34′ N.	152°26′ W.	M	127
Oct. 30, 1952	2°15′ N.	151°19′ W.	In	149
Oct. 27, 1952	5°34′ N.	152°26′ W.	In	140
Oct. 30, 1952	2°15′ N.	151°19′ W.	In	137
Oct. 27, 1952	5°34′ N.	152°26′ W.	In	135
Oct. 28, 1952	4°00′ N.	152°20′ W.	In	133
Oct. 25, 1950	7°17′ N.	157°04′ W.	M	143
Oct. 31, 1950	6°25′ N.	162°26′ W.	Im	99
Do	6°25′ N.	162°26′ W.	Im	95
Do	6°25′ N.	162°26′ W.	Im	95
Do	6°25′ N.	162°26′ W.	Im	88
Nov. 1, 1952	7°33′ S.	120°21′ W.	M	138
Do	7°33′ S.	120°21′ W.	In	139
Do	7°33′ S.	120°21′ W.	In	127
Do	7°33′ S.	120°21′ W.	In	123
Do	7°33′ S.	120°21′ W.	Im	153
Nov. 6, 1952	3°11′ S.	130°17′ W.	M	132
Do	3°11′ S.	130°17′ W.	Im	150
Nov. 3, 1952	1°00′ N.	151°26′ W.	In	[1] 145
Do	1°00′ N.	151°26′ W.	In	142
Nov. 2, 1952	2°13′ N.	151°51′ W.	In	135
Nov. 6, 1950	5°53′ N.	162°05′ W.	M	146
Nov. 7, 1950	6°13′ N.	163°05′ W.	M	134
Nov. 8, 1950	6°59′ N.	163°54′ W.	M	133
Nov. 9, 1950	7°24′ N.	164°23′ W.	M	133
Nov. 30, 1950	6°25′ N.	162°26′ W.	M	129
Nov. 9, 1950	7°24′ N.	164°23′ W.	In	143
Nov. 16, 1950	3°52′ N.	159°20′ W.	In	143
Nov. 24, 1950	6°13′ N.	158°53′ W.	In	140
Nov. 19, 1950	1°12′ N.	160°21′ W.	In	139
Nov. 1, 1950	1°51′ N.	157°30′ W.	In	136
Nov. 21, 1950	3°52′ N.	159°57′ W.	In	134
Do	3°52′ N.	159°57′ W.	In	132
Nov. 24, 1950	6°13′ N.	158°53′ W.	In	122
Nov. 20, 1950	2°55′ N.	160°20′ W.	Im	143
Do	2°55′ N.	160°20′ W.	Im	141
Nov. 19, 1950	1°12′ N.	160°21′ W.	Im	138
Nov. 20, 1950	2°55′ N.	160°20′ W.	Im	137
Nov. 23, 1950	5°04′ N.	159°03′ W.	Im	137
Nov. 21, 1950	3°52′ N.	159°57′ W.	Im	136
Do	3°52′ N.	159°57′ W.	Im	135
Nov. 23, 1950	5°04′ N.	159°03′ W.	Im	135
Nov. 16, 1950	3°52′ N.	159°20′ W.	Im	130
Do	3°52′ N.	159°20′ W.	Im	130
Do	3°52′ N.	159°20′ W.	Im	122
Nov. 24, 1950	6°13′ N.	158°53′ W.	Im	122
Nov. 6, 1950	5°53′ N.	162°05′ W.	Im	120
Nov. 16, 1950	3°52′ N.	159°20′ W.	Im	120
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	120
Nov. 24, 1950	6°13′ N.	158°53′ W.	Im	118
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	114
Nov. 3, 1950	6°25′ N.	162°26′ W.	Im	110
Nov. 28, 1950	5°53′ N.	162°05′ W.	Im	110
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	107
Nov. 2, 1950	4°42′ N.	160°24′ W.	Im	105
Nov. 16, 1950	3°54′ N.	159°26′ W.	Im	104
Nov. 24, 1950	4°42′ N.	160°24′ W.	Im	103
Nov. 2, 1950	4°42′ N.	160°24′ W.	Im	102
Nov. 6, 1950	5°53′ N.	162°05′ W.	Im	101
Nov. 22, 1950	4°42′ N.	160°24′ W.	Im	101
Do	4°42′ N.	160°24′ W.	Im	99
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	99
Nov. 24, 1950	4°42′ N.	160°24′ W.	Im	98
Nov. 17, 1950	3°52′ N.	159°20′ W.	Im	96
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	94
Nov. 27, 1950	5°53′ N.	162°05′ W.	Im	93
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	92
Nov. 27, 1950	5°53′ N.	162°05′ W.	Im	88
Nov. 24, 1950	4°42′ N.	160°24′ W.	Im	87
Nov. 28, 1950	5°53′ N.	162°05′ W.	Im	86
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	85
Nov. 24, 1950	4°42′ N.	160°24′ W.	Im	85
Nov. 4, 1950	6°25′ N.	162°26′ W.	Im	83
Nov. 3, 1950	6°25′ N.	162°26′ W.	Im	83
Nov. 22, 1950	4°42′ N.	160°24′ W.	Im	81
Nov. 2, 1950	6°25′ N.	162°26′ W.	Im	78
Nov. 4, 1950	5°53′ N.	162°05′ W.	Im	77
Nov. 22, 1950	4°42′ N.	160°24′ W.	Im	77
Nov. 24, 1950	4°42′ N.	160°24′ W.	Im	76
Do	4°42′ N.	160°24′ W.	Im	71
Nov. 28, 1950	5°53′ N.	162°05′ W.	Im	68
Nov. 4, 1950	6°25′ N.	162°26′ W.	Im	63
Nov. 27, 1950	5°53′ N.	162°05′ W.	Im	63
Nov. 30, 1950	6°25′ N.	162°26′ W.	Im	61
Nov. 20, 1952	3°36′ S.	170°02′ W.	R	142
Nov. 11, 1950	6°25′ N.	167°32′ W.	M	153
Nov. 23, 1952	1°00′ S.	169°27′ W.	M	135
Nov. 24, 1952	0°04′ N.	168°48′ W.	M	132
Nov. 26, 1952	2°24′ N.	168°44′ W.	In	139
Nov. 19, 1952	5°00′ S.	170°08′ W.	In	131
Dec. 12, 1953	4°14′ N.	154°56′ W.	In	126
Do	4°14′ N.	154°56′ W.	Im	114
Do	4°14′ N.	154°56′ W.	Im	114
Do	4°14′ N.	154°56′ W.	Im	103
Dec. 6, 1953	2°27′ N.	155°26′ W.	In	148
Dec. 11, 1953	3°31′ N.	155°23′ W.	In	147
Dec. 7, 1953	1°59′ N.	156°09′ W.	In	146
Dec. 3, 1953	1°28′ S.	155°25′ W.	In	144
Do	1°28′ S.	155°25′ W.	In	142
Dec. 8, 1953	2°14′ N.	157°08′ W.	In	140
Dec. 2, 1953	3°02′ S.	155°12′ W.	In	138
Dec. 5, 1953	1°22′ N.	155°18′ W.	In	137
Dec. 11, 1953	3°31′ N.	155°23′ W.	In	137
Dec. 6, 1953	2°27′ N.	155°26′ W.	In	136
Do	2°27′ N.	155°26′ W.	In	134
Do	2°27′ N.	155°26′ W.	In	127
Dec. 1, 1953	4°33′ S.	155°08′ W.	In	123
Dec. 2, 1953	3°02′ S.	155°12′ W.	In	122
Dec. 7, 1953	1°59′ N.	156°09′ W.	In	118
Dec. 8, 1953	2°14′ N.	157°08′ W.	In	110
Dec. 7, 1953	1°59′ N.	156°09′ W.	In	107
Do	1°59′ N.	156°09′ W.	In	105
Dec. 8, 1953	2°14′ N.	157°08′ W.	In	105
Do	2°14′ N.	157°08′ W.	In	103
Do	2°14′ N.	157°08′ W.	In	103
Dec. 2, 1953	3°02′ S.	155°12′ W.	In	88
Dec. 9, 1953	2°01′ N.	158°15′ W.	In	87
Dec. 3, 1953	1°28′ S.	155°25′ W.	Im	144
Dec. 7, 1953	1°59′ N.	156°09′ W.	Im	144
Dec. 9, 1953	2°01′ N.	158°15′ W.	Im	144
Dec. 11, 1953	3°31′ N.	155°23′ W.	Im	144
Do	3°31′ N.	155°23′ W.	Im	144
Dec. 3, 1953	1°28′ S.	155°25′ W.	Im	142
Do	1°28′ S.	155°25′ W.	Im	141
Dec. 11, 1953	3°31′ N.	155 23′ W.	Im	141

[1] From length-weight relation.

TABLE 1.—*Data on 740 yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the laboratory*—Continued

Date	Position		Stage of maturity	Fish length	Date	Position		Stage of maturity	Fish length
	Latitude	Longitude				Latitude	Longitude		
				Cm.					*Cm.*
Dec. 7, 1953	1°59′ N.	156°09′ W.	Im	138	Dec. 8, 1953	2°14′ N.	157°08′ W.	Im	105
Dec. 11, 1953	3°31′ N.	155°23′ W.	Im	138	Do	2°14′ N.	157°08′ W.	Im	105
Do	3°31′ N.	155°23′ W.	Im	137	Do	2°14′ N.	157°08′ W.	Im	104
Dec. 7, 1953	1°59′ N.	156°09′ W.	Im	136	Do	2°14′ N.	157°08′ W.	Im	103
Dec. 11, 1953	3°31′ N.	155°23′ W.	Im	129	Dec. 9, 1953	2°01′ N.	158°15′ W.	Im	103
Dec. 1, 1953	4°33′ S.	155°08′ W.	Im	125	Dec. 8, 1953	2°14′ N.	157°08′ W.	Im	102
Dec. 5, 1953	1°22′ N.	155°18′ W.	Im	123	Do	2°14′ N.	157°08′ W.	Im	99
Dec. 2, 1953	3°02′ S.	155°12′ W.	Im	121	Do	2°14′ N.	157°08′ W.	Im	98
Dec. 7, 1953	1°59′ N.	156°09′ W.	Im	120	Do	2°14′ N.	157°08′ W.	Im	98
Dec. 2, 1953	3°02′ S.	155°12′ W.	Im	119	Do	2°14′ N.	157°08′ W.	Im	98
Dec. 6, 1953	2°27′ N.	155°26′ W.	Im	119	Do	2°14′ N.	157°08′ W.	Im	97
Do	2°27′ N.	155°26′ W.	Im	116	Do	2°14′ N.	157°08′ W.	Im	97
Dec. 2, 1953	3°02′ S.	155°12′ W.	Im	115	Do	2°14′ N.	157°08′ W.	Im	94
Dec. 7, 1953	1°59′ N.	156°09′ W.	Im	110	Dec. 9, 1953	2°01′ N.	158°15′ W.	Im	94
Dec. 8, 1953	2°14′ N.	157°08′ W.	Im	110	Dec. 8, 1953	2°14′ N.	157°08′ W.	Im	88

On several cruises, observations were made on the state of maturity of ovaries which, with a few exceptions, were then discarded. Although these field observations were subjective and liable to differences between observers, they were used to supplement the seasonal and areal coverage. After discussion with the various observers, and after comparisons of field observations with laboratory classifications, we were able to classify most of the ovaries reliably into two groups, "inactive" (immature and intermediate) and "active" (maturing and ripe). Field classifications are given in table 2. Questionable observations were not considered, and are not included in the table.

TABLE 2.—*Data on yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the field*

[A, active; I, inactive]

Date	Position		Stage of maturity	Fish length	Date	Position		Stage of maturity	Fish length
	Latitude	Longitude				Latitude	Longitude		
				Cm.					*Cm.*
May 28, 1954	4°02′ N.	159°34′ W.	A	149	June 11, 1954	0°26′ S.	158°57′ W.	A	146
May 30, 1954	3°58′ N.	159°04′ W.	A	140	June 14, 1954	0°13′ S.	160°02′ W.	A	146
May 28, 1954	4°02′ N.	159°34′ W.	A	139	June 15, 1954	0°30′ S.	160°19′ W.	A	146
Do	4°02′ N.	159°34′ W.	A	123	June 3, 1954	1°43′ N.	158°28′ W.	A	144
May 17, 1954	5°58′ N.	162°52′ W.	A	120	June 7, 1954	1°52′ N.	156°47′ W.	A	143
May 27, 1954	4°17′ N.	160°28′ W.	A	118	June 15, 1954	0°30′ S.	160°19′ W.	A	143
May 28, 1954	4°02′ N.	159°34′ W.	A	114	Do	0°30′ S.	160°19′ W.	A	143
Do	4°02′ N.	159°34′ W.	I	118	June 11, 1954	0°26′ S.	158°57′ W.	A	142
Do	4°02′ N.	159°34′ W.	I	116	June 14, 1954	0°13′ S.	160°02′ W.	A	142
Do	4°02′ N.	159°34′ W.	I	114	June 10, 1954	0°50′ N.	158°53′ W.	A	141
Do	4°02′ N.	159°34′ W.	I	109	June 15, 1954	0°30′ S.	160°19′ W.	A	140
May 30, 1954	3°58′ N.	159°04′ W.	I	108	Do	0°30′ S.	160°19′ W.	A	140
May 25, 1954	4°45′ N.	160°11′ W.	I	106	June 13, 1954	0°18′ S.	160°16′ W.	A	139
May 28, 1954	4°02′ N.	159°34′ W.	I	106	June 14, 1954	0°13′ S.	160°02′ W.	A	137
Do	4°02′ N.	159°34′ W.	I	103	June 12, 1954	0°14′ S.	160°00′ W.	A	135
Do	4°02′ N.	159°34′ W.	I	102	June 13, 1954	0°18′ S.	160°16′ W.	A	134
May 27, 1954	4°17′ N.	160°28′ W.	I	101	June 14, 1954	0°13′ S.	160°02′ W.	A	133
May 30, 1954	3°58′ N.	159°04′ W.	I	100	June 12, 1954	0°14′ S.	160°00′ W.	A	132
May 25, 1954	4°45′ N.	160°11′ W.	I	98	June 13, 1954	0°18′ S.	160°16′ W.	A	132
May 30, 1954	3°58′ N.	159°04′ W.	I	97	June 10, 1954	0°50′ N.	158°53′ W.	A	128
Do	3°58′ N.	159°04′ W.	I	96	June 14, 1954	0°13′ S.	160°02′ W.	A	127
Do	3°58′ N.	159°04′ W.	I	93	June 12, 1954	0°14′ S.	160°00′ W.	A	126
Do	3°58′ N.	159°04′ W.	I	93	Do	0°14′ S.	160°00′ W.	A	125
Do	3°58′ N.	159°04′ W.	I	93	Do	0°14′ S.	160°00′ W.	A	122
Do	3°58′ N.	159°04′ W.	I	92	Do	0°14′ S.	160°00′ W.	A	120
Do	3°58′ N.	159°04′ W.	I	92	Do	0°14′ S.	160°00′ W.	A	120
Do	3°58′ N.	159°04′ W.	I	91	Do	0°14′ S.	160°00′ W.	A	120
Do	3°58′ N.	159°04′ W.	I	91	June 8, 1954	2°01′ N.	157°09′ W.	A	117
Do	3°58′ N.	159°04′ W.	I	91	June 15, 1954	0°30′ S.	160°19′ W.	A	92
Do	3°58′ N.	159°04′ W.	I	89	June 8, 1954	2°01′ N.	157°09′ W.	I	122
May 25, 1954	4°45′ N.	160°11′ W.	I	88	June 12, 1954	0°14′ S.	160°00′ W.	I	122
May 30, 1954	3°58′ N.	159°04′ W.	I	88	Do	0°14′ S.	160°00′ W.	I	121
Do	3°58′ N.	159°04′ W.	I	88	Do	0°14′ S.	160°00′ W.	I	119
Do	3°58′ N.	159°04′ W.	I	87	June 13, 1954	0°18′ S.	160°16′ W.	I	118
Do	3°58′ N.	159°04′ W.	I	86	June 8, 1954	2°01′ N.	157°09′ W.	I	116
May 25, 1954	4°45′ N.	160°11′ W.	I	84	June 12, 1954	0°14′ S.	160°00′ W.	I	116
May 30, 1954	3°58′ N.	159°04′ W.	I	83	June 4, 1954	2°03′ N.	157°40′ W.	I	115
June 15, 1954	0°30′ S.	160°19′ W.	A	151	June 13, 1954	0°18′ S.	160°16′ W.	I	108
June 14, 1954	0°13′ S.	160°02′ W.	A	150	June 4, 1954	2°03′ N.	157°40′ W.	I	104
June 15, 1954	0°30′ S.	160°19′ W.	A	150	Do	2°03′ N.	157°40′ W.	I	102
June 12, 1954	0°14′ S.	160°00′ W.	A	147	June 8, 1954	2°01′ N.	157°09′ W.	I	94

TABLE 2.—*Data on yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the field*—Continued

Date	Position		Stage of maturity	Fish length	Date	Position		Stage of maturity	Fish length
	Latitude	Longitude				Latitude	Longitude		
				Cm.					*Cm.*
Aug. 25, 1952	3°26′ N.	140°08′ W.	A	142	Aug. 24, 1953	4°43′ N.	160°00′ W.	I	99
Aug. 27, 1952	1°33′ N.	140°13′ W.	I	154	Do	4°43′ N.	160°00′ W.	I	96
Do	1°33′ N.	140°13′ W.	I	152	Do	4°43′ N.	160°00′ W.	I	96
Do	1°33′ N.	140°13′ W.	I	150	Do	4°43′ N.	160°00′ W.	I	95
Do	1°33′ N.	140°13′ W.	I	150	Do	4°43′ N.	160°00′ W.	I	93
Do	1°33′ N.	140°13′ W.	I	149	Do	4°43′ N.	160°00′ W.	I	88
Aug. 25, 1952	3°26′ N.	140°08′ W.	I	148	Sept. 7, 1952	1°42′ N.	141°24′ W.	I	156
Aug. 26, 1952	2°23′ N.	140°12′ W.	I	148	Sept. 3, 1952	4°04′ N.	140°09′ W.	I	150
Do	2°23′ N.	140°12′ W.	I	148	Sept. 7, 1952	1°42′ N.	141°24′ W.	I	149
Aug. 27, 1952	1°33′ N.	140°13′ W.	I	148	Sept. 9, 1952	2°33′ N.	143°22′ W.	I	148
Aug. 28, 1952	1°00′ N.	140°22′ W.	I	148	Sept. 2, 1952	3°05′ N.	140°02′ W.	I	147
Aug. 25, 1952	3°26′ N.	140°08′ W.	I	147	Do	3°05′ N.	140°02′ W.	I	145
Aug. 27, 1952	1°33′ N.	140°13′ W.	I	147	Sept. 5, 1952	2°25′ N.	140°32′ W.	I	145
Do	1°33′ N.	140°13′ W.	I	144	Sept. 2, 1952	3°05′ N.	140°02′ W.	I	144
Aug. 28, 1952	1°00′ N.	140°22′ W.	I	144	Sept. 7, 1952	1°42′ N.	141°24′ W.	I	143
Aug. 26, 1952	2°23′ N.	140°12′ W.	I	142	Sept. 9, 1952	2°33′ N.	143°22′ W.	I	143
Aug. 27, 1952	1°33′ N.	140°13′ W.	I	142	Sept. 1, 1952	3°31′ N.	140°28′ W.	I	142
Do	1°33′ N.	140°13′ W.	I	141	Sept. 7, 1952	1°42′ N.	141°24′ W.	I	139
Do	1°33′ N.	140°13′ W.	I	141	Sept. 5, 1952	2°25′ N.	140°32′ W.	I	136
Do	1°33′ N.	140°13′ W.	I	138	Sept. 11, 1952	2°57′ N.	147°22′ W.	A	157
Aug. 26, 1952	2°23′ N.	140°12′ W.	I	132	Sept. 18, 1952	3°39′ N.	151°54′ W.	A	150
Aug. 24, 1952	4°28′ N.	139°51′ W.	I	131	Sept. 16, 1952	2°28′ N.	150°38′ W.	A	146
Aug. 28, 1952	1°00′ N.	140°22′ W.	I	121	Sept. 18, 1952	3°39′ N.	151°54′ W.	A	144
Aug. 24, 1952	4°28′ N.	139°51′ W.	I	112	Sept. 19, 1952	3°49′ N.	152°10′ W.	A	143
Aug. 27, 1953	9°00′ N.	159°40′ W.	A	147	Sept. 15, 1952	2°05′ N.	150°23′ W.	A	142
Aug. 25, 1953	6°10′ N.	160°02′ W.	A	141	Sept. 19, 1952	3°49′ N.	152°10′ W.	A	142
Aug. 26, 1953	7°50′ N.	159°24′ W.	A	140	Sept. 18, 1952	3°39′ N.	151°54′ W.	A	138
Do	7°50′ N.	159°24′ W.	A	140	Sept. 16, 1952	2°28′ N.	150°38′ W.	A	137
Aug. 21, 1953	1°11′ N.	160°08′ W.	A	134	Sept. 17, 1952	3°26′ N.	151°40′ W.	A	137
Aug. 22, 1953	2°08′ N.	160°24′ W.	A	128	Sept. 16, 1952	2°28′ N.	150°38′ W.	A	135
Aug. 27, 1953	9°00′ N.	159°40′ W.	A	128	Sept. 11, 1952	2°57′ N.	147°22′ W.	I	148
Aug. 22, 1953	2°08′ N.	160°24′ W.	A	123	Sept. 14, 1952	1°48′ N.	150°05′ W.	I	144
Do	2°08′ N.	160°24′ W.	A	107	Sept. 10, 1952	2°08′ N.	145°21′ W.	I	143
Aug. 24, 1953	4°43′ N.	160°00′ W.	I	140	Sept. 11, 1952	2°57′ N.	147°22′ W.	I	143
Aug. 22, 1953	2°08′ N.	160°24′ W.	I	125	Sept. 15, 1952	2°05′ N.	150°23′ W.	I	142
Aug. 24, 1953	4°43′ N.	160°00′ W.	I	112	Sept. 14, 1952	1°48′ N.	150°05′ W.	I	135
Do	4°43′ N.	160°00′ W.	I	111	Sept. 10, 1952	2°08′ N.	145°21′ W.	I	134
Aug. 23, 1953	3°22′ N.	160°24′ W.	I	108	Sept. 15, 1952	2°05′ N.	150°23′ W.	I	134
Do	3°22′ N.	160°24′ W.	I	104	Sept. 13, 1952	1°22′ N.	149°54′ W.	I	133
Do	3°22′ N.	160°24′ W.	I	100	Sept. 16, 1952	2°28′ N.	150°38′ W.	I	117

Additional data (table 3) are available from field observations reported by the Iwate Prefecture Fishery Experiment Station (1953a and 1953b), which were obtained from Japanese longline expeditions into this area. As with the POFI field observations, the stages of maturity were combined into two groups, "active" and "inactive", and the "spent" category was disregarded. Other pertinent information found in these reports is as follows: The fishing area for the April cruise was between latitudes 9° N. and 11° N. and longitudes 170° W. and 173° W. Fish caught on this cruise ranged from 110 to 150 cm. in length, with only one fish measuring less than 120 cm. Fishing during June and July was done at 3° N. to 4° N. and 175° W. to 177° W. Fork lengths ranged from 114 to 173 cm., with only two fish measuring less than 120 cm. Eighty percent of the fish were caught in June, and the rest were caught in July.

TABLE 3.—*Number of yellowfin tuna in various stages of maturity, according to Iwate Prefecture Fishery Experiment Station*

Date	Immature	Maturing	Mature	Ripe	Spent	Location	
						Longitude	Latitude
Apr. 4–24, 1953	3	4	10	14	4	9° N.–11° N.	170° W.–173° W.
June 22–July 3, 1953	29	41	97	26	22	3° N.–4° N.	175° W.–177° W.

Note.—For further data see station reports (1953a and 1953b).

SIZE OF FISH AT FIRST SPAWNING

To determine the size of first-spawning fish, the fork lengths collected by POFI were grouped into classes of 10 cm., and the percentage of fish in the "active" category (maturing and ripe stages), as determined by ovary examination, was calculated for each length class. The results, illustrated in figure 1, show that all the fish smaller than 70 cm. were in a nonspawning condition. In the 70-to-79-cm. class (about 15 to 22 lbs.), 6.9

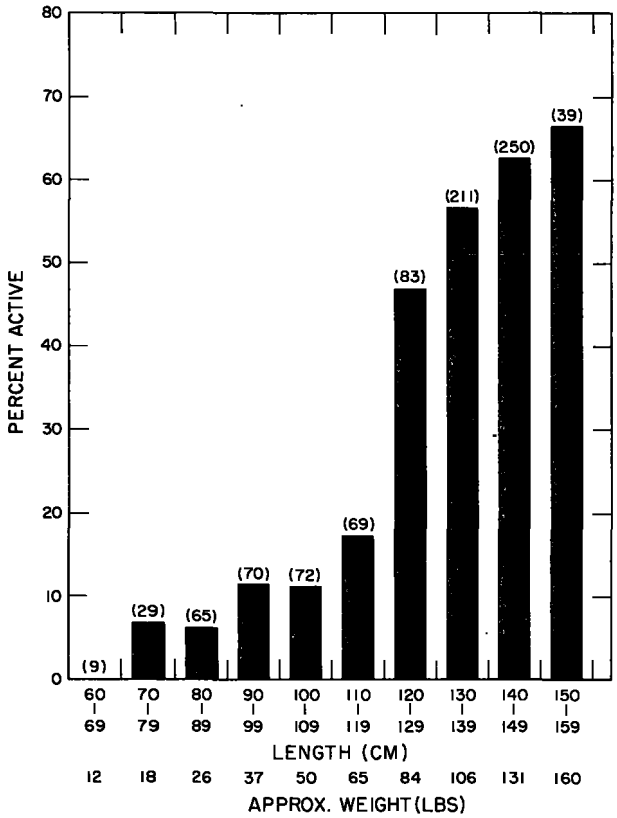

FIGURE 1.—Percentages of sexually active fish at different fork lengths. Figures in parentheses indicate the numbers of individuals on which the percentages are based.

percent were in the maturing or ripe stages. The percentage of sexually active fish increased gradually and irregularly from this length class through the 110-to-119-cm. class (about 57 to 72 lbs.), of which 17.4 percent were active. In the next 10-cm. class (about 74 to 92 lbs.), the percentage of reproductively active fish jumped sharply to 47.0 percent. Above this class the percentage of active fish increased steadily with length. Of the fish measuring 150 to 159 cm. (about 145 to 172 lbs.), 66.7 percent were active.

These data suggest that, although yellowfin as small as 70 cm. are capable of reproducing, the greater part of the population reaches sexual maturity at about 120 cm. Schaefer and Marr (1948), however, noted that in Costa Rican waters yellowfin ranging from 70 to 100 cm. spawn later in the year than the larger fish. This presents the possibility that larger fish have longer spawning periods than smaller fish, which in turn suggests that the smaller percentage of sexually active fish from 70 to 120 cm. in our samples may have resulted from a shorter spawning season rather than from a difference between the proportions of sexually mature fish above 120 cm. and those below 120 cm. Although the representation of fish from 70 to 120 cm. for each month is spotty in our samples, an examination of the monthly percent maturing and ripe (table 4) shows the peak percentage to be far less than that reached by the larger fish. This supports our interpretation of the results, that is, that the greater part of the population reaches sexual maturity at about 120 cm.

TABLE 4.—*Monthly percentages of sexually active yellowfin tuna below 120 cm. fork length*

Month	Fraction active	Percent active
January	1/12	8.3
February	2/26	7.6
March	0/1	0.0
April	2/18	11.0
May	11/101	10.0
June	11/45	24.4
July	0/1	0.0
August	3/24	12.5
September	4/12	33.3
October	0/4	0.0
November	0/31	0.0
December	0/33	0.0

LOCALITY OF SPAWNING

The data were grouped by months and by 10-degree longitudinal sections. The data for those ovaries collected between 115°00′ W. and 124°59′ W. are shown in table 5 in the 120° W. longitudinal section (the midpoint of that section), those collected between 125°00′ and 134°59′ W. in the 130° W. section, and so on, with the exception of the 180° section, which includes 175°00′ W. to 180°. Because the percentage of sexually active fish below 120 cm. was so much smaller, only fish above this size were considered in order to get results that could be used for comparison. The percentage of active fish for each month for each 10-degree section was calculated. The percentages for June and July along 180° were calculated from summarized Japanese data, which did not separate the catch of those 2 months. To arrive at the monthly totals for these months (in the extreme right-hand column of table 5), the 193 fish caught along 180° were separated into 154 fish for June and 39 fish for July, because 80 percent of the catch was made in June.

The results (table 5) show that all the sections had at least one month in which 85 percent or more of the fish were sexually active. This, coupled

TABLE 5.—*Fractions of samples of sexually active yellowfin tuna (maturing and ripe) at various longitudes, by months*

[Percentage of sexually mature fish in sample in parentheses]

Month	At longitude—							Total
	180°	170° W.	160° W.	150° W.	140° W.	130° W.	120° W.	
January			1/6 (16.7%)					1/6 (16.7%)
February	9/11 (81.8%)	1/2 (50.0%)	13/32 (40.6%)	14/30 (46.7%)				37/75 (49.3%)
March		14/16 (87.5%)		1/1 (100.0%)	34/35 (97.1%)			49/52 (94.2%)
April		28/31 (90.3%)						28/31 (90.3%)
May		7/8 (87.5%)	23/27 (85.2%)				4/4 (100.0%)	34/39 (87.2%)
June	131/154 (85.0%)	7/9 (77.8%)	38/43 (88.4%)			9/10 (90.0%)	1/1 (100.0%)	186/217 (85.7%)
July	33/39 (85.0%)	2/3 (66.7%)						35/42 (83.3%)
August			37/53 (69.8%)	7/7 (100.0%)	11/39 (28.2%)			55/99 (55.6%)
September			5/18 (27.8%)	83/115 (72.2%)	22/30 (73.3%)			110/163 (67.5%)
October			1/1 (100.0%)	3/8 (37.5%)			1/3 (33.3%)	5/12 (41.7%)
November		4/6 (66.7%)	5/28 (17.9%)	0/3 (0.0%)		1/2 (50.0%)	1/5 (20.0%)	11/44 (25.0%)
December			0/31 (0.0%)	0/1 (0.0%)				0/32 (0.0%)

with the fact that larvae below 10 mm. have been found in all of these sections (Matsumoto[1]) indicates that yellowfin spawning occurs throughout the central equatorial Pacific. The fact that spawning probably occurs throughout the entire equatorial Pacific is indicated by additional records of spawning yellowfin in the western area by Wade (1950 and 1951), Marr (1948), and Shimada (1951), and in the eastern area by Schaefer and Marr (1948) and Mead (1951).

TIME OF SPAWNING

The percentage of sexually active fish of 120 cm. and longer was calculated for each month of the year and was plotted on a graph (fig. 2). Yellowfin that had almost reached the spawning state were found in each month except December, and the greatest percentages of active fish occurred from March (94.2%) through July (83.3%). It was only during November, December, and January that the occurrence of maturing and ripe fish dropped below 40 percent. This, however, does not prove that spawning is a year-round activity, inasmuch as the length of time that the fish are in these stages before spawning is not known.

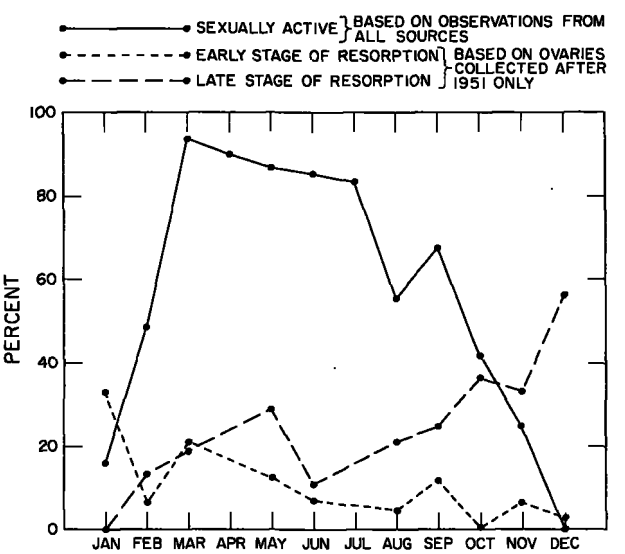

FIGURE 2.—Monthly percentages of yellowfin tuna sexually active or with residual eggs.

To define the spawning season further, the occurrence of residual eggs in these larger fish was investigated with respect to time. The results, plotted in figure 2, show that ovaries with early-

[1] Matsumoto, Walter M.: Descriptions of four species of tuna larvae and their distribution in central Pacific waters. POFI. (Unpublished MS.)

stage residual eggs have the same occurrence pattern as maturing and ripe ovaries. This is true for all the months except January, which is represented by an inadequate sample. The occurrence of these early-stage residual eggs indicates that spawning actually is a year-round occurrence.

Spawning in other equatorial areas of the Pacific likewise seems to be protracted. Schaefer and Marr (1948) found indications of a prolonged spawning season off Costa Rica. Wade (1950) found that the spawning period of yellowfin in the Philippine Islands extended over a considerable period, but that it was most intense during May, June, July, and August. It is probable that the prolonged spawning season is accompanied by multiple spawning—in other words, there is more than one spawning per fish in a spawning season. June (1953) considered this to be true for yellowfin in Hawaiian waters, after studying the progression of modal groups in egg-diameter frequencies.

DESCRIPTION OF STAGES IN RESORPTION OF RESIDUAL EGGS

In the beginning of this study, several structures found in the ovaries could not be readily identified. As more ovaries were examined, it became evident that these structures were the remains of ripe eggs from a previous spawning which were in different stages of resorption. The following descriptions of these stages are based on gross microscopic examination and are intended to aid future workers in recognizing these structures.

Immediately after spawning, these residual eggs (fig. 3) generally resemble the ripe eggs, except that they become shrivelled owing to shrinking of the yolk mass and the resulting collapse of the chorion. The oil sac is usually ruptured, and the released oil appears as bright yellow droplets. The eggs at this stage are still loose and translucent.

Subsequently the eggs lose their translucence and collect in masses of semiopaque tubules. The eggs are not within the tubule but are entangled in the many disordered convolutions of the tubule.

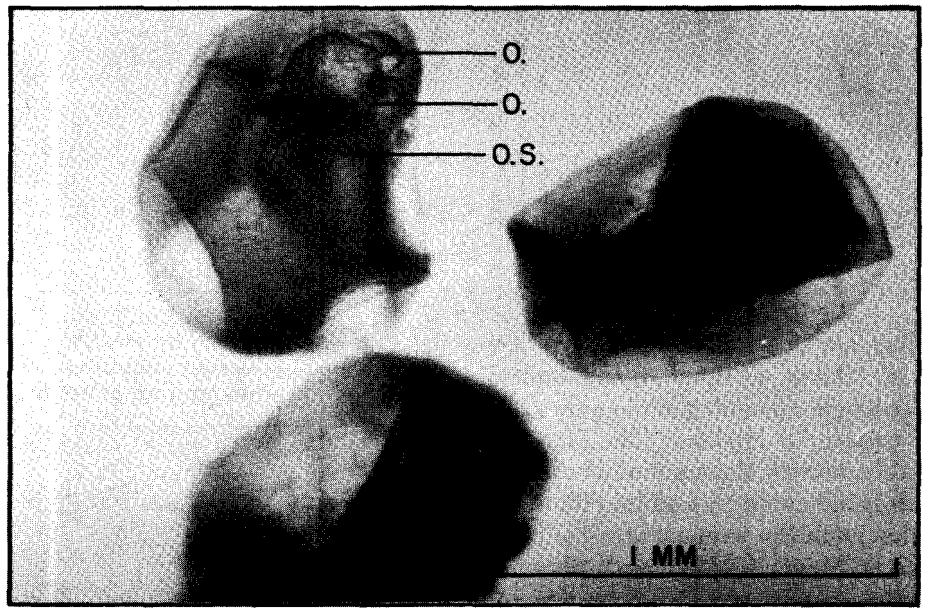

FIGURE 3.—Individual residual eggs; O., oil droplet; O. S., oil sac.

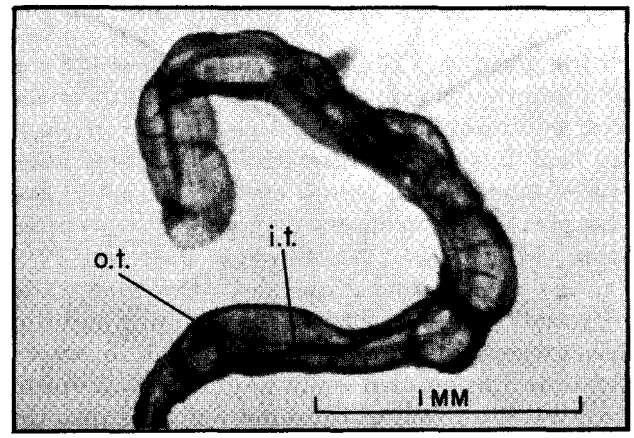

FIGURE 4.—Piece of tubule teased from ovary with residual eggs; i. t., inner tubule; o. t., outer tubule.

The tubular diameter is about 0.20 mm. Within this tubule lies another tubule with a diameter of 0.05 mm. Circular transverse ridges on the wall of the outer tubule give it a striated appearance. Figure 4 shows a short section of a tubule that had been teased from a mass.

Histologically, these masses of tubules and eggs are found to be surrounded by a connective tissue stroma (fig. 5). The wall of the outer tubule seems to be composed of reticular connective tissue. The wall of the inner tubule is made up of a single layer of closely arranged minute cells (3 μ diameter) with relatively large, deep-staining nuclei.

The origin and function of these tubules are open to question, but their proximity to the residual eggs suggests that they are involved in the absorption of these eggs.

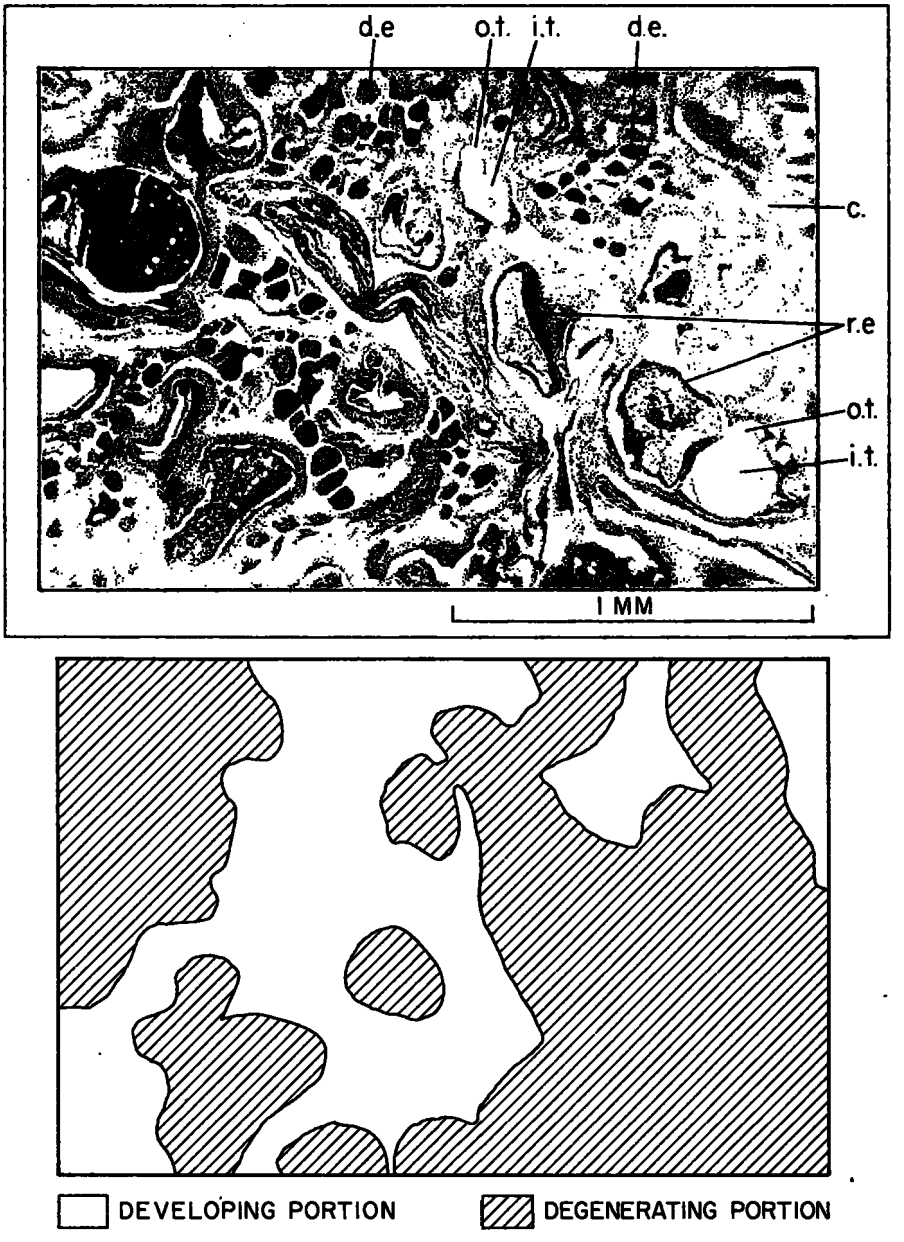

FIGURE 5.—Above: Part of section through ovary showing residual egg mass *in situ*; c., connective tissue capsule; d. e., developing egg; i. t., inner tubule; o. t., outer tubule; r. e., residual egg. Below: Diagram of this section, outlining developing and degenerating portions.

The masses of eggs, tubules, and connective tissue which are scattered throughout the ovary appear to shrink with the passage of time. An examination of later stages shows that the residual eggs are not arranged entirely haphazardly but are lined up to form indistinct cords (fig. 6). These masses eventually shrink to nondescript particles (fig. 7) before they are finally lost in the ovary.

OCCURRENCE OF NEMATODES IN THE OVARIES

While examining the eggs, we observed several ovaries with nematodes, ranging from 0.5 cm. to 4 cm. in length. The specimens were in too poor a state of preservation to identify.

Of 25 ovaries examined for nematodes, 22 (88%) were infested. The extent of infestation did not appear to be serious enough to affect the

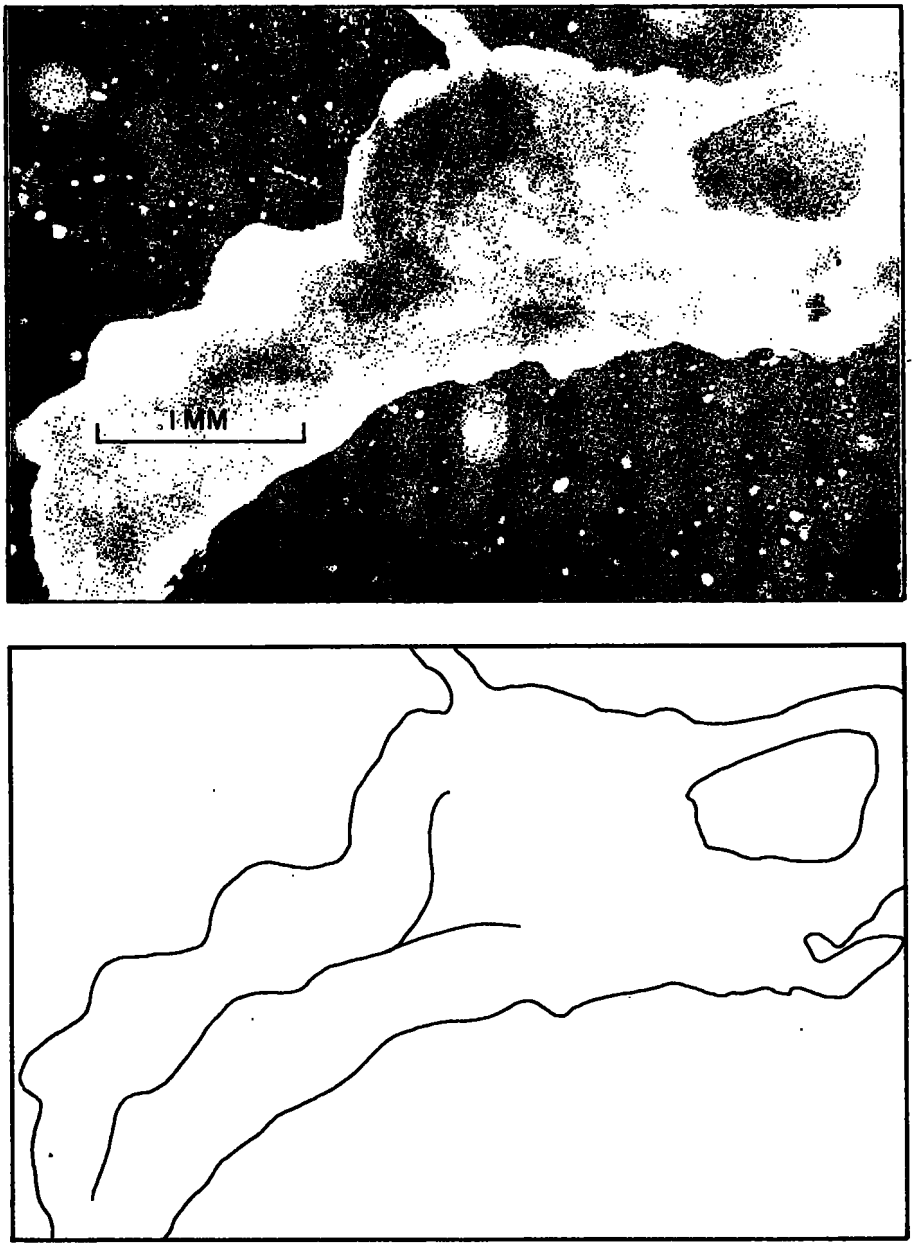

FIGURE 6.—Above: Residual egg mass teased from ovary. Below: Diagram of this mass, outlining the rows of eggs.

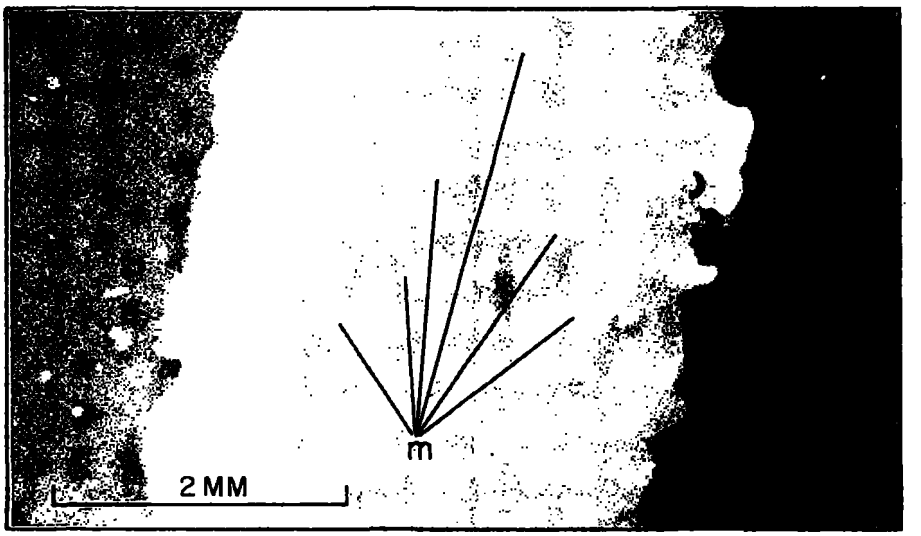

FIGURE 7.—Part of ovary showing shrunken masses of residual eggs; m., mass of residual eggs.

functioning of the ovaries. There were seldom more than five worms in a single ovary, and in only one instance did the ovarian tissue seem to be pathological owing to heavy infestation. Fish with infested ovaries were found throughout the central equatorial Pacific.

SUMMARY

This study is based on data obtained in the field relative to the time and place of spawning and the size of yellowfin tuna at time of spawning, and on laboratory examination of ovaries of yellowfin tuna obtained on POFI exploratory-fishing trips made in the central equatorial Pacific from February 1950 to June 1954. Study of the ovaries and of the data on the size and distribution of the spawning fish led to the following conclusions: (1) The size at sexual maturity may be as small as 70 cm., but usually is greater than 120 cm.; (2) the spawning season extends throughout most of the year, with November, December, and January the months of lowest spawning intensity; (3) the spawning grounds seem to include the entire equatorial Pacific.

During the course of this investigation, stages in the resorption of residual eggs were observed and described.

Unidentified nematodes were found in 88 percent of a sample of 25 ovaries. In most instances, the nematodes did not seem to be present in sufficient numbers to affect egg production seriously.

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